Two-tailed P values and Hypothesis Tests:

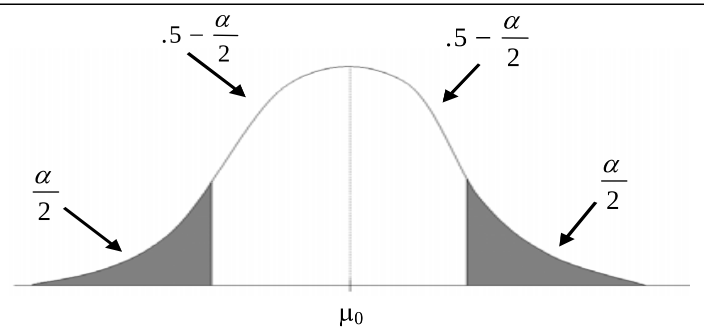
Purpose	Test statistic	Decision rule or p value	Notes
Compare **1 mean** to a benchmark **(large sample)**	$z = \frac{\bar{x} - \mu_{null}}{S / \sqrt{n}}$	Reject null if $\lvert z \rvert > z_{\alpha/2}$ p =2xPr($\lvert Z \rvert > \lvert z \rvert$)	If α =.05, $z_{\alpha/2}$=1.96 If α =.01, $z_{\alpha/2}$=2.58 If α =.10, $z_{\alpha/2}$=1.65
Compare **1 proportion** to a benchmark **(large sample)**	$z = \frac{\hat{p} - p_{null}}{\sqrt{\frac{p_{null}(1-p_{null})}{n}}}$	Reject null if $\lvert z \rvert > z_{\alpha/2}$ p =2xPr(($\lvert Z \rvert > \lvert z \rvert$	Critical values as above
Compare **2 means** from independent samples **(large samples)**	$z = \frac{(\overline{x_1} - \overline{x_2}) - (\mu_1 - \mu_2)_{null}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$	Reject null if $\lvert z \rvert > z_{\alpha/2}$ p =2xPr(($\lvert Z \rvert > \lvert z \rvert$	Can use this if both n > 30.
Compare **2 means** from independent samples **(small samples)**	$t = \frac{(\overline{x_1} - \overline{x_2}) - (\mu_1 - \mu_2)_{null}}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$ $s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$	Reject null if $\lvert t \rvert > t_{\alpha/2}$ Get t critical value from t table with df= n_1+n_2-2 p =2xPr(($\lvert T \rvert > \lvert t \rvert$)	Must assume variables have approx. normal distributions with equal variance for the subpopulations.

Compare **2 proportions** from independent samples	$z=\frac{(\hat{p}_1-\hat{p}_2)-D_{null}}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$ $\hat{p}=\frac{x_1+x_2}{n_1+n_2}$	Reject null if $\lvert z\rvert > z_{\alpha/2}$ p =2xPr(($\lvert Z\rvert > \lvert z\rvert$)	For large subsamples only (each n at least 30).
Compare **2 means** from **paired samples**	$z=\frac{\overline{D}-\mu_{D_0}}{\frac{s_D}{\sqrt{n}}}$	Reject null if $\lvert z\rvert > z_{\alpha/2}$ p =2xPr(($\lvert Z\rvert > \lvert z\rvert$)	Use same formula with t distribution for small sample (if differences are distributed approx. normal).

<u>Hypothesis Test Procedure: *Is our sample information far enough away from the null that it is inconsistent?*</u>

1. **Establish hypotheses H_0: μ =? H_a: μ□?**
2. **Set the decision rule:**
   Draw a picture; pick α; Find $z_{\alpha/2}$ or $t_{\alpha/2}$ If $|z|>z_{\alpha/2}$ then reject the null hypothesis.
3. **Find z or t statistic (like z-score)**
4. **Compare test statistic to critical value. Reject or no reject?**

Rejection Regions (In Grey)

Is $|z|>z_\alpha$? That is, is our test statistic too far from the null value for us to believe our sample came from that population? Then reject the null hypothesis.	

<u>P value (Observed significance) Procedure:</u>
<u>What's the chance of getting a sample value at least this far away from the null if the null is true?</u>

1. **Establish hypotheses H_0: μ=? H_a: $\mu \neq$?**
2. **Find estimate of mean and SE**
3. **Find test statistic (like Z score)**
4. **Find p value (probability) associated with test statistic from t or Z table**
   p = Pr(|Z|> test stat)=?? (DF=n-1 if use t table)